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Performance of Sudan Desert Sheep Fed Different Nitrogen Levels in Molasses-based Fattening Rations

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Abstract: Twenty-four yearling uncastrated males of Sudan desert sheep (Hamari ecotype), ranging in weight between 26 and 30 kg, were used in a completely randomized design with the objective of studying the effect of feeding different nitrogen levels (14.5%, 16.7% and 18.7% crude protein) in complete isocaloric molasses-based fattening diets on sheep performance, some rumen metabolites (ammonia nitrogen) and blood urea nitrogen. There was no significant treatment effect on average final weight, average daily gain, daily dry matter intake, daily water intake or feed conversion ratio. There was a tendency of increased growth rate and dry matter intake with the increase of nitrogen level. The best feed conversion ratio was found at 14.5% crude protein, whereas 16.7% crude protein exhibited the least. There was a significant ($P<0.05$) treatment effect on rumen pH when samples were taken before feeding. Treatment had no significant effect on ammonia nitrogen or blood urea nitrogen when samples were taken before and six hours after feeding. However, treatment failed also to induce a significant ($P<0.05$) effect on ammonia nitrogen three hours after feeding.

Key words: Sheep; nitrogen level; performance

INTRODUCTION

Decreasing of grazing land and inadequate feed supply are the major problems facing livestock producers in Sudan. Most of the crop residues are used as livestock feed, but their supply is seasonal and they are used in a traditional way without any pretreatment and/or strategic supplementation.

Protein is one of the most limiting nutrients in sheep fattening rations formulated from agricultural (e.g., groundnut hulls) and agro-industrial by-products (e.g., molasses). To achieve rapid gains, rations need to be supplemented with dietary protein, since high protein levels seemed to promote growth. Haddad *et al*. (2001) obtained the highest average daily gain (ADG) with 16% and 18% crude protein (CP) diets when Awassi lambs were fed high concentrate isocaloric diets that contained 10%, 12%, 14%, 16% and 18% CP in a totally mixed diet. Fluharty and McClure (1997) recorded a 19% improvement in ADG for fattening lambs fed 18% CP diet compared with a 14.5% CP diet. Thomson *et al*. (1995) reported that increasing dietary CP from 10% to 13% CP increased dry matter intake (DMI), ADG and feed conversion ratio (FCR) in cattle fed high-concentrate diets. In a subsequent study, Gleghorn *et al*. (2004) indicated that increasing CP concentration from 11.5% to 13% slightly increased ADG. Increasing CP concentration to 14.5% did not improve performance or carcass characteristics. Willms *et al*. (1991) provided further evidence that fattening diets based on alkaline hydrogen peroxide-treated wheat straw supplemented with soybean meal to contain 12% or 14% CP had similar DMI, ADG and efficiency of gain when fed to ram lambs. The reasons for such responses are not clear but are of paramount importance from a production standpoint. The level of protein also affects ammonia nitrogen (NH_3-N) and blood urea nitrogen (BUN). Increasing the CP content of diets results in increased concentrations of ruminal NH_3-N and BUN and, consequently, greater nitrogen (N) losses (Bunting *et al*. 1987; Castillo *et al*. 2001). Previous research suggests that BUN greater than 8 mg/100 ml are indicative of excessive N intake and N wastage (Cole *et al*. 2003).

The objective of this study was to determine growth responses of yearling Sudan desert sheep to molasses-based fattening rations supplemented with natural protein (groundnut seed cake) and non-protein N (urea) to levels of 14.5%, 16.7% and 18.7% CP on dry matter (DM) basis.

MATERIALS AND METHODS

Feeding trial

Twenty-four yearling uncastrated males of Sudan desert sheep (Hamari ecotype) ranging in weight between 26 and 30 kg were used in this study. The animals were purchased from the local market. On arrival at the experimental farm, they were treated with Levafas against endoparasites and sprayed with Gamatox for the control of ectoparasites and given a prophylactic dose of Alamycine. The animals were left to acclimatize for 14 days, during this period the animals were divided according to their live weight into three groups of eight animals each and allotted at random to each of the experimental rations under investigation. The rations contained different CP levels (14.5%, 16.7% and 18.7% CP for treatments T_1, T_2 and T_3, respectively) through increasing percentages of urea (1.7%, 2.5% and 3%) and were offered *ad libitum* in the fattening trial for 70 days. The rations were calculated to be isocaloric. The detailed composition of the rations is presented in Table 1. Feed intake and body weight were recorded bi-weekly. Daily records were made for water intake and evaporation rate.

The sheep's pens were in the open and shaded. Each pen was provided with a 90 litres half barrel set approximately 12.5 cm in the ground to prevent its being upset. The half barrels were calibrated by weighing exactly 90 kilogrammes of water into each. The height of water was measured and the kilogrammes of water per centimetre depth were calculated and each barrel was then marked. Control half barrels to measure evaporation rate were set and calibrated in a similar manner. Water consumed by each group of sheep during each day was determined by measuring the depletion of water in the barrels and by correcting for evaporation. Measurements were made every day at the same time during the period of the trial. The animals in each group were fed and watered in group.

Table 1. Percentage of ingredients and chemical composition of the experimental rations

	T_1	T_2	T_3
Ingredients[*1]			
Molasses	40.00	40.00	40.00
Wheat bran	29.30	28.50	28.00
Groundnut hulls	20.00	20.00	20.00
Groundnut seed cake	8.00	8.00	8.00
Urea	1.70	2.50	3.00
Salt	0.95	0.95	0.95
Vit./mineral supplement[*2]	0.05	0.05	0.05
Total	100	100	100
Dry matter analysis (%)			
Ash	8.34	10.55	9.47
Organic matter	91.66	89.45	90.53
Ether extract	2.10	1.95	4.10
Crude fibre	10.50	10.75	10.65
Crude protein	14.53	16.71	18.73
Nitrogen free extract	64.53	60.04	57.06
ME (MJ/kg DM)*3	11.95	11.56	12.04

T_1:14.5% CP; T_2: 16.7% CP; T_3: 18.7% CP

[*1] on as fed basis (%)

[*2] Avico Products, Jordan

Each 1 g of vitamin supplement contains:

Vitamin A	8000 IU	Vitamin B_{12}	5 mcg	Iron	22 mg
Vitamin D_3	1400 IU	Ca-d pantothenate	5 mg	Manganese	33 mg
Vitamin E	2 mg	Zinc	25 mg	Copper	2.2 mg
Vitamin K_3	2 mg	Nicotinamide (B_3)	15 mg	Cobalt	0.5 mg
Vitamin B_2	4 mg	Choline Chloride	100 mg	Iodine	1.1 mg
Vitamin B_1	2 mg	Folic Acid	0.5 mg		

[*3] Calculated after MAFF (1975), using the following equation:

ME (MJ/kg DM) = 0.0I2CP+0.03 I EE+0.005 CF+0.014NFE

At the end of the feeding trial, the sheep were fasted for 24 hours, then they were offered their normal rations *ad libitum*. Samples of rumen liquor were obtained by means of stomach tube immediately before feeding and 3 hrs and 6 hrs after feeding. The rumen pH was measured immediately, using Electronic pH meter (Model 41600).The rumen liquor samples were then strained through 4 layers cheesecloth after they were centrifuged at 3000 rpm for 5 minutes and kept for immediate analysis. Ruminal NH_3-N was determined as described by Conway (1957). Blood samples were withdrawn from jugular vein immediately before feeding and 3 hrs and 6 hrs post-feeding. The blood samples were allowed to clot, and the serum was separated by centrifugation and stored at - 20°C until assayed for blood urea (Conway 1957). The samples of feed offered were taken weekly and bulked at the end of the feeding trial. The collection composites were divided into portions: one dried at 60˚C and the other at 105˚C for chemical analysis and DM determinations, respectively. Feed samples were then ground through a 1-mm mesh screen for analysis. The samples of rations were analysed for their proximate chemical components as described by AOAC (1980).

Statistical analysis

Data from the feeding trial were arranged in a completely randomized design and subjected to analysis of variance, according to the general linear models procedure of SAS (1990). Duncan multiple range test was used for mean separation at P=0.05.

RESULTS AND DISCUSSION

Effect of N level on animal performance

Growth, DMI, water intake (WI) and FCR, as affected by N level in the concentrate, are presented in Table 2. There was no significant treatment effect on average final weight, ADG, daily DMI, WI or FCR.

No significant treatment effect was found for ADGs. They were 0.15, 0.15 and 0.16 kg for 14.5%, 16.7% and 18.7% protein diets, respectively. These results agree with those reported by Harb (1994) who fed Awassi lambs six high concentrate diets containing a range of 14.7%-19.9% dietary CP and obtained no significant difference for ADG. The tendency of ADG to be greater for the sheep, fed an increased amount of dietary protein, agrees with the results obtained by De Gracia and Ward (1991) when dietary CP was increased in iso-caloric diets fed to mature beef cows. Gleghorn *et al*. (2004) demonstrated also that increasing the concentration of supplementary urea linearly increased ADG. The additional protein, fed in our study, may have met an amino acid deficiency *per se* (Whitelaw *et al*. 1985) or may have improved the efficiency of metabolizable energy (ME) utilization. Veitia *et al*. (1980) reported that increase in protein level produces an increase in ME consumption, feeding level, corrected ME consumption and energy availability for fattening. In the present study, DMI increased with increasing the protein concentration of the isocaloric diets fed to sheep. The increase in DMI resulted in an increase in energy intake. This may explain the higher ADG in T_3 than in the other two treatments.

Table 2. Growth, dry matter intake, water intake and feed conversion ratio in sheep fed different nitrogen levels

Item	T_1	T_2	T_3
Experimental period (days)	70	70	70
Number of animals	8	8	8
Initial wt (kg)	28.50±1.18[a]	28.41±1.36[a]	27.72±1.25[a]
Final wt (kg)	38.75±1.87[a]	38.84±4.75[a]	38.94±6.80[a]
Total gain (kg/70 days)	10.25±1.84[a]	10.43±4.07[a]	11.22±3.99[a]
Average daily gain (kg)	0.15±0.03[a]	0.15±0.06[a]	0.16±0.06[a]
Daily DMI (kg)	1.26±0.25[a]	1.44±0.11[a]	1.47±0.06[a]
Feed conversion ratio	8.40±2.28[a]	9.60±3.51[a]	9.19±6.17[a]
Kg TDN*/kg gain	5.00±0.27[a]	5.47±0.12[a]	5.94±0.44[a]
Water intake (kg/day)	4.06±0.09[a]	4.57±1.19[a]	4.38±1.14[a]
Kg water intake/kg DMI	3.22±1.05[a]	3.17±0.70[a]	2.98±0.59[a]

T_1:14.5% CP; T_2: 16.7% CP; T_3: 18.7% CP

Means with similar superscript in a row are not significantly different at P>0.05.

* Data not shown

The daily DMI was 1.26, 1.44 and 1.47 kg for T_1, T_2 and T_3, respectively. The insignificant increase in DMI with the increase of CP levels agrees with the results obtained by Pathak and Sharma (1991) who fed isocaloric rations containing 8.81%, 11.32% and 13.58% CP to adult goats. They found that the mean DMI/100 kg body weight and per kilogramme metabolic body size ($W^{0.75}$) were a little higher in group 1 (8.81% CP) than in the other two groups, but the differences between the groups were not significant. Archibeque *et al*. (2007) reported also non significant difference in DMI by steers fed low (9%), medium (11.8%) or high (13.9%) CP diets. The trend of increase in their study, however, was inconsistent. Haddad *et al*. (2001) reported, however, a significant increase in DMI with increasing levels of dietary CP. Inclusion of urea in the ration might have increased the rate of passage and digestion in the rumen, which stimulated the animals to consume more DM (Sharma and Mudgal 1975).

Sheep fed 14.5% CP (8.4 kg feed/kg gain) were more efficient in feed conversion than those fed 16.7% (9.6 kg feed/kg gain) or 18.7% (9.19 kg feed/kg gain). No significant treatment effect was found in FCR. Haddad *et al*. (2001) found no significant difference in FCR between diets containing 14%, 16% or 18% CP. They reported that Awassi lambs fed diets containing 14% CP gained less weight than those fed the 16% and 18% CP diets. Our results are in line with those obtained by Stiles *et al*. (1974) who found no effect on ADGs, feed intake or feed efficiency in Holstien bull-calves fed high concentrate rations containing 12%, 15% or 18% CP (as fed basis). Harb (1994) fed Awassi lambs six high concentrate diets that contained a range of 14.7%-19.9% dietary CP and obtained no significant difference in ADG and FCR.

Effect of N level on some rumen metabolites and BUN

In treatments T_1 and T_2, ruminal pH was neither significantly affected by N level nor by sampling time (Table 3). However, a significant ($P<0.05$) difference was found in T_3 when 6 hrs after feeding value was compared with the fasting or 3 hrs after feeding values. Before feeding, ruminal pH showed a significant ($P<0.05$) difference between T_3 and the other two treatments. These results are in line with those obtained by Willms *et al*.

(1991) who reported treatment effect on rumen pH. Contrary evidence was presented, however, by Nolte *et al*. (2000) who reported no effect of protein level on ruminal pH values. No significant effect of treatment was detected when rumen pH was measured 6 hrs after feeding.

Ruminal-NH_3 concentrations (Table 3) were neither significantly affected by sampling time nor by diet. These results agree with those obtained by Ahmed (1989). Contrary findings were presented by several research workers (e.g., Bunting *et al*. 1987; Willms *et al*. 1991; Castillo *et al*. 2001) who reported increased NH_3-N concentration with increasing CP level.

The peak NH_3-N concentration was obtained 3 hrs after feeding, and this was higher than 6 hrs after feeding values. The highest NH_3-N concentration was observed with T_1 (14.5% CP). Within each treatment, ruminal NH_3-N was higher 6 hrs after feeding than the fasting value except in T_3 where the two values were similar.

Table 3. Effect of nitrogen level on ruminal metabolites and blood urea nitrogen

Parameter	Sampling Time (hr)	T_1	T_2	T_3
pH	-24	7.42 ± 0.03^{a}	7.36 ± 0.07^{a}	7.10 ± 0.15^{b}
	3	6.23 ± 0.25^{a}	6.58 ± 0.09^{ab}	6.31 ± 0.14^{b}
	6	6.71 ± 0.26^{a}	6.95 ± 0.12^{a}	6.81 ± 0.17^{a}
NH_3-N (mg/100ml ruminal fluid)	-24	17.68 ± 2.28^{a}	14.53 ± 2.82^{a}	15.58 ± 6.67^{a}
	3	22.23 ± 3.45^{a}	20.65 ± 1.67^{a}	19.75 ± 4.68^{a}
	6	18.43 ± 4.62^{a}	15.58 ± 3.35^{a}	15.58 ± 4.40^{a}
BUN (mg/100ml blood)	-24	26.69 ± 5.23^{a}	26.23 ± 6.23^{a}	30.63 ± 7.76^{a}
	3	44.63 ± 5.98^{a}	46.81 ± 4.60^{ab}	39.38 ± 3.35^{b}
	6	26.25 ± 3.78^{a}	32.38 ± 6.47^{a}	32.81 ± 5.78^{a}

T_1:14.5% CP; T_2: 16.7% CP; T_3: 18.7% CP

Values are means ± SD of 4 animals.

Values in the same column or row with common superscripts are not significantly different at P>0.05.

Although NH_3-N levels varied among diets, NH_3-N concentrations were in the optimal range for all diets. The NH_3-N concentration was higher than the optimal ruminal NH_3-N concentration of 5 mg/100 ml reported by Satter and Slyter (1974) as being necessary for maximal protein synthesis. Owens and Bergen (1983) indicated that concentrations ranging between 0.35 and 29 mg/100 ml promote maximal microbial growth. The highest level of NH_3-N production was obtained with the diet containing the lowest N level (14.5% CP) which probably reflects inadequate energy supply to promote microbial protein synthesis (MPS) in this diet. The concentration of NH_3-N in the rumen is a function of both rate of ruminal N degradation and concentration of ruminally degradable protein above microbial needs and the amount of dietary energy available to the rumen microorganisms. If the diet provides the rumen with sufficient amount of degradable protein/ NH_3-N, energy intake is the primary factor explaining the variability in MPS (Oldick *et al*. 1999).

BUN was also affected by treatment and time after feeding (Table 3). Generally, there was a tendency of increased BUN with the increase of N concentration in the diet (except for samples taken 3 hrs after feeding in T_3 which were lower than BUN values in T_2 and T_1). These results are in line with those reported by Pathak and Sharma (1991), Rusche *et al*. (1993) and Castillo *et al*. (2001). They found significant increase in BUN with the increase of N level in the diet. The increased BUN concentrations with increased dietary protein probably can be explained largely by increased absorption of ruminal NH_3 resulting in greater quantities of NH_3 being detoxified in the liver from urea (Rusche *et al*. 1993). Increasing dietary CP concentration to 18.7% increased BUN, thus, providing evidence that this concentration exceeded the requirements of sheep in this experiment. Cole *et al*. (2003) stated that high BUN gives an indication to the excessive N intake and N wastage.

BUN was affected by sampling time in T_3 only, as 3 hrs after feeding values were significantly different from both fasting and 6 hrs after feeding values. Three hours after feeding, BUN increased in all treatments. At 6 hrs after feeding, BUN decreased ($P>0.05$) in all treatments. Maximum increase in BUN 3 hrs after feeding was attained in T_2 (46.81 mg/100 ml blood), followed by T_1 (44.63 mg/100 ml blood) and the least increase by T_3 (39.38 mg/100 ml blood). The only treatment effect ($P<0.05$) was detected when samples taken 3 hrs after feeding in T_3 were compared with T_1 (no significant difference was found between T_2 and the other two treatments). The faster turnover of urea in animals on high protein rations may be a result of greater loss of urea in urine through a greater water intake. This would also reduce plasma urea concentration and, therefore, urea degradation in the digestive tract (Sharma *et al*. 1974). Contrary finding was reported by Castillo *et al*. (2001) who observed increased BUN with the increase of CP content of dairy cows diets.

In conclusion, ADG by Sudan desert sheep fed molasses-based fattening diets respond to increased CP concentration, with maximal responses in ADG with 18.7% CP diet. This implies that high protein levels are beneficial, but high feeding cost and low animal performance must be taken into consideration. More work based on diets with different levels of protein (lower than those used in this study) is required to determine the best protein level to support high growth rates and better carcass traits in Sudan desert sheep.

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مجلة جامعة الخرطوم للعلوم الزراعية : المجلد التاسع عشر – العدد الثانى ، 2011م

أداء الضأن الصحراوى السودانى المغذى على مستويات نيتروجين مختلفة فى علائق تسمين مبنية أساساً على المولاس

عاصم عبد الرازق على لطفى وسعاد أحمد فضل

قسم الإنتاج الحيوانى ، معهد أبحاث التصحر – المركز القومى للبحوث ، الخرطوم – السودان

المستخلص: إستخدم 24 رأساً من ذكور الضأن الصحراوى السودانى ، الغير مخصى والبالغة سنة من العمر ووزنها بين 26 و 30 كجم ، فى تصميم كامل العشوائية ، بهدف دراسة تأثير تغذية مستويات مختلفة من النيتروجين (14.5% و 16.7% و 18.7% بروتين خام) فى علائق تسمين كاملة متساوية فى محتواها من الطاقة ومبنية أساساً على المولاس على أداء الضأن ، وبعض نواتج التخمير فى الكرش (الأمونيا) ويوريا الدم . لم يكن هنالك تأثير معنوي للمعاملة على متوسط الوزن النهائى ، أو متوسط الزيادة اليومية فى الوزن ، وكمية المادة الجافة المأكولة يومياً، وكمية مياه الشرب المستهلكة يومياً ، أو معدل التحويل الغذائى . كان هنالك ميل لزيادة معدل النمو وكمية المادة الجافة المأكولة بزيادة مستوى النيتروجين . أفضل معدل تحويل غذائى وجد عند مستوى 14.5% بروتين خام بينما أظهر مستوى 16.7% بروتين خام أقل معدل تحويل غذائى. كان هنالك تأثير معنوي للمعاملة على الرقم الهيدروجيني فى الكرش عندما أخذت العينات قبل تقديم العليقة . لم يكن للمعاملة تأثير معنوي على الأمونيا – نيتروجين ويوريا الدم عندما أخذت العينات قبل تقديم العليقة و 6 ساعات بعد تقديمها . من ناحية ثانية، فشلت المعاملة فى إحداث تأثير معنوي على الأمونيا – نيتروجين ثلاث ساعات بعد تقديم العليقة .